POWER REQUIREMENTS FOR COMMUNITY DIAL CENTRAL OFFICE EQUIPMENT

CONTENTS

1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses in particular the methods used in calculating the power requirements for dial central offices. It provides means to calculate the required capacities of the storage batteries and charging equipment for particular applications.

1.2 This revision replaces REA TE&CM 302, Issue No. 3, dated January 1962. It is being reissued to include power calculation methods for various common control equipment, tone dialing equipment and toll ticketing equipment.

1.3 Paragraphs 17.0 and 18.0, respectively, of Part III, REA Form 558c, "Detailed Central Office Equipment Requirements," and paragraphs 8.1 and 8.2, respectively, of Part III, REA Form 524c, "Specification for Common Control Central Office Equipment Detailed Equipment Requirements," cover the general specifications governing the supply, by the manufacturer, of storage battery and charging equipment for use with an REA borrower's proposed dial central office (CDO). Based upon these general specifications, determination of the required capacities of the battery and charger is made by the manufacturer.

2. BASIS FOR CALCULATIONS

2.1 The charging equipment furnished with a dial central office must have sufficient capacity to supply the dc power necessary for the satisfactory operation of the office during the busy hour. This is exclusive of the power requirements for any ac equipment but includes the dc requirements for carrier, loop extenders, voice frequency repeaters, ANI, etc.

2.12 Determination of the requirements for emergency generating and charging equipment is covered in REA TE&CM 320, "Emergency Generating and Charging Equipment."

2.2 Charging equipment for common control offices should be provided on one of the following bases:

(a) Two chargers either capable of carrying the full office load, or

(b) Three chargers each capable of carrying half the office load.

(See Exhibit E for example.)

Although required for common control offices only, this arrangement may be desirable for larger size direct control offices. If so, it should be noted in paragraph 23 of REA Form 558.

2.3 Storage Battery

2.31 The storage battery furnished with a dial central office must have sufficient capacity to supply the dc power necessary to sustain satisfactory operation of the exchange for the period specified in paragraph 17.0 of REA Form 558c, or paragraph 8.1 of REA Form 524c, in the event of failure of the commercial (ac) power supply. This includes appropriate allowances for any equipment which is normally ac operated but arranged for dc operation in case of a power failure.

3. CALCULATIONS

3.1 Attached Exhibits A through N outline the procedures to be followed in calculating the power requirements (charger and battery) for dial central office equipment of the following types:

Exhibit A: Switch Type Equipment as Manufactured by Automatic Electric, ITT and Stromberg-Carlson

North Electric NX-2A Crossbar Equipment

Leich All-Relay Equipment

Exhibit B: Stromberg-Carlson ESC-1

Exhibit C: Stromberg-Carlson ESC-3

Exhibit D: ITT A-1

Exhibit E: ITT PC-32B

Exhibit F: Automatic Electric CXP-5

Exhibit G: Automatic Electric No. 1 - EAX

Exhibit H: North Electric NX-1D

Exhibit I: North Electric NX-1E

Exhibit J: Northern Electric SP-1

Exhibit K: Nippon Electric NC-23, NC-400, and NC-460

Exhibit L: Stromberg-Carlson Toll Ticketing

Exhibit M: ITT Tel Touch

Exhibit N: Stromberg-Carlson Tone Dialing

Exhibit O: Lists various power requirements for loop extenders, voice frequency repeaters and carrier equipment.

Exhibit P: Illustrates the method used in determining the capacity of the storage battery required for a particular application. This ibit also illustrates, in Example 2, a method used to calculate the ere hour reserve of existing batteries when the current requirement the central office equipment is changed as a result of equipment itions, higher than anticipated calling rates, etc.

In connection with the calculation of the required capacity of the charger, a ten (10) percent allowance is made, i.e., if 110 percent the rated output of the charger is equal to or greater than the culated charger dc current requirement, the charger supplied shall considered as satisfactorily meeting the specification requirments.

In some cases a voltage regulator is added in series with the battery supply of the central office to maintain float voltage ing ac power outages. These voltage regulators are electronic dc dc converters which sense the battery voltage and add additional tage to maintain the office at float voltage. They automatica connect the load just before the batteries are discharged to ere permanent damage may result. The maintenance on voltage r very low, making them desirable for use in unattended offices er required to operate the converter plus the additional powe se the battery voltage to float voltage during discharge make essary to increase the ampere hour rating of the battery as c this section by 23 percent. The normal charger capacity shou reased by 10 percent.

When Automatic Number Identification is installed in a cent office, the additional current drain on the dc supply is ca follows:

Two amperes for the common equipment, and 0.3 amperes for e interoffice trunk associated with the ANI equipment.

3.7 It should be kept in mind that the calculation methods shown in this section are to provide estimates only. Engineering judgment must be used for each individual application. It is, therefore, recommended that the manufacturers of the systems being considered be consulted for specific applications.

EXHIBIT A

Busy Hour Current Drain Calculations
for Various Switchboards
(All Values in Amperes)

Type of Drain	Switch Type (XY, SxS)	North NX-2A Crossbar	Leich Dial (Linefinder-Selector-Connector)
Equipment Holding (See Note 1)	0.72/T.C.U.	0.6/T.C.U. (See Note 5)	1.17/T.C.U.
General Operating	0-100 Lines 1.0 101-200 Lines 1.5 201-400 Lines 2.0 401+ Lines 3.0	1st Line Group 1.0 Each Add'l. Line Group 0.5	4.0
Additional Equipment	-	-	0.3/100 Lines
Manual Toll Board	2.0/Position	2.0/Position	2.0/Position
DC Operated Ringing Generator (See Note 2)	0-100 Lines 2.0 101+ Lines 3.0	3.0	0-100 Lines 2.0 101+ Lines 3.0
Interoffice Trunk Circuit	0.35/2W & 1W Incoming Trunk 0.30/1W Outgoing Trunk (See Note 4)	0.25/Trunk (See Note 4)	1.0 (See
Special Equipment (See Note 3)	As Required	As Required	As R

EXHIBIT A NOTES

Notes:

1. A "Time Call" Unit is calculated as follows:

$$T.C.U. = \frac{\text{Unit Calls Per Line X Total Number of Lines}}{36}$$

2. When the primary ringing generator is ac operated, no provision need be made in the charger capacity to handle the standby ringing generator. The generator drain must be included when calculating battery capacity.

3. This includes the power requirements for carrier, loop extenders, voice frequency repeaters, ANI, etc., (see Exhibit O). Where special equipment is normally ac operated and requires dc only for standby, no provision need be made in the charger capacity. The drain must be included when calculating battery capacity.

4. If the number of interoffice trunk groups equals four or more for switch type equipment (more than four for NX-2A), it is satisfactory to use three-quarters (3/4) of the total trunk circuit current drain.

5. When conversation time disconnect is equipped, add 0.2 amperes per T.C.U. to the holding drain.

6. A Trunk "Time Call" Unit (T.T.C.U.) is calculated as follows:

$$T.T.C.U. = \frac{\text{Unit Call Capacity of Trunk Group (P.01)}}{36}$$

7. If the total busy hour drain is not in excess of ten percent above a standard charger size, that charger may be used. If the above total exceeds ten percent, the next larger standard charger size should be used.

Examples:

The following office will be used in each of these examples. Assume a 360 line office has a calling rate of 2.0 unit calls per line with 6 two-way toll trunks and 8 two-way EAS trunks terminated on incoming selectors. Also assume that dc operated carrier and VF repeaters have a drain of 3 amperes. The primary ringing generator is ac operated in Examples 1 and 3.

$$T.C.U. = \frac{2.0 \text{ UC/L X } 360 \text{ Lines}}{36} = 20$$

Exhibit A Examples Continued

1. Switch Type Equipment:

Equipment Holding Drain = 20 X 0.72	= 14.4
General Operating Drain	= 2.0
No Toll Board	-
Primary Ringing Generator - AC Operated	-
Trunk Drain = 14 X 0.35	= 4.9
Special Equipment Drain	= 3.0
Total Drain	24.3 Amps

2. North NX-2A Crossbar:

Equipment Holding Drain = 20 X 0.6	= 12.0
General Operating Drain = $1.0 + \frac{270}{90} \times 0.5$	= 2.5
Primary Ringing Generator - DC Operated	= 3.0
Trunk Drain = 14 X 0.25	= 3.5
Special Equipment Drain	= 3.0
Total Drain	24.0 Amps

3. Leich Dial:

Equipment Holding Drain = 20 X 1.17	= 23.4
General Operating Drain	= 4.0
Additional Equipment Drain = $\frac{360}{100} \times 0.3$	= 1.1
Primary Ringing Generator - AC Operated	-
Trunk Drain:	
6 Toll Trunks (P.01) will handle 64.4 UC	
Toll Group Drain = $\frac{64.4}{36} \times 1.08$	= 1.9
8 EAS Trunks (P.01) will handle 105 UC	
EAS Group Drain = $\frac{105}{36} \times 1.08$	= 3.2
Special Equipment Drain	= 3.0
Total Drain	36.6 Amps

The above total drains should be used in determining charger size. For calculating battery capacity three amperes should be added to Examples 1 and 3 to account for ringing generator current drain.

EXHIBIT B

Stromberg-Carlson ESC-1

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control (Local) Cabinets (CCL) [1]	-	-	-		16	
4-Stage Trunk Link Network(TLN)		93		-	-	-
6-Stage Trunk Link Network(TLN)		102		-	-	-
Common Control(Trunk) Cabinets (CCT)		10			7	
Register Sender Cabinets(RS)		1			10	
Auxiliary Register Sender Cabinets (RSA)		3			10	
Translator Cabinets	-	5	5	-	42	42
TLN Cabinet(Control) (TLC)	1	10	10	1	8	8
Supervisory Cabinet (CSR)	1	6	6	1	12	12
Powerboard (1 Frequency)		7		-	-	-
(2 Frequencies)		9		-	-	-
(4 Frequencies)		15		-	-	-
Automatic Call Generator	1	3	3	1	5	5
DC-DC Converter (-24v) [2]		11		-	-	-
Loop Extender Power Supply[2]		4		-	-	-
Pre-Pay Power Supply		2		-	-	-
Tandem Trunks[3]		.015		-	-	-
Recording Trunks		Note 4			Note 4	
LAMA Cabinets		24			16	
CAMA Cabinets		13			7	
Maintenance Test Console		5			2	
Registers	-	-	-		1	
Senders	-	-	-		1	
Customer Drain		As Req'd.			As Req'd.	
Total Drain	48-Volt			8-Volt		

EXHIBIT B NOTES

Notes:

1. When the number of line units are odd, round off to next even number.

2. Do not include drain for redundant equipment.

3. Incoming Tandem Trunk CCS X .015 = Total Current

4.

Recording Trunks Equipped	Drain in Amperes 48-Volt	8-Volt
1 - 50	7	57
51 - 100	8	68
101 - 150	9	79
151 - 200	10	90
201 - 250	11	102
251 - 300	13	113
301 - 350	14	124
351 - 400	15	136

5. When SCAMA-LAMA ticketing is required, the following drains should be added:

Ultimate DDD Trunk Capacity	8V Drain	48V Drain
50	57 amps	7 amps
100	68	8
150	79	9
200	90	10
250	111	11
300	113	13
350	124	14
400	136	15

6. When CAMA is required, the following drains should be added:

48V Drain - 24 amps
8V Drain - 16 amps

EXAMPLE

Stromberg-Carlson ESC-1
1500 Lines
5000 Directory Numbers

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control (Local) Cabinets (CCL) [1]	-	-	-	1	16	16
4-Stage Trunk Link Network(TLN)	1	93	93	-	-	-
6-Stage Trunk Link Network(TLN)		102		-	-	-
Common Control(Trunk) Cabinets (CCT)	1	10	10	1	7	7
Register Sender Cabinets(RS)	1	1	1	1	10	10
Auxiliary Register Sender Cabinets (RSA)		3			10	
Translator Cabinets	-	5	5	-	42	42
TLN Cabinet(Control) (TLC)	1	10	10	1	8	8
Supervisory Cabinet (CSR)	1	6	6	1	12	12
Powerboard (1 Frequency)		7		-	-	-
(2 Frequencies)		9		-	-	-
(4 Frequencies)	1	15	15	-	-	-
Automatic Call Generator	1	3	3	1	5	5
DC-DC Converter (-24v) [2]	1	11	11	-	-	-
Loop Extender Power Supply[2]	2	4	8	-	-	-
Pre-Pay Power Supply	2	2	4	-	-	-
Tandem Trunks[3]	100 ccs	.015	1.5	-	-	-
Recording Trunks		Note 4			Note 4	
LAMA Cabinets		24			16	
CAMA Cabinets	1	13	13	1	7	7
Maintenance Test Console	1	5	5	1	2	2
Registers	-	-	-	80	1	80
Senders	-	-	-	20	1	20
Customer Drain		As Req'd.	15		As Req'd.	
Total Drain		48-Volt	200.5		8-Volt	209

EXHIBIT C

Stromberg-Carlson ESC-3

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control Cabinet		23.8			48.6	
Translator		4.2			77.7	
Test Cabinet		3.7			10.0	
Power Supervisory		24.7		-	-	-
Register Common	-	-	-		12.0	
Call Generator		0.6			4.8	
MF Current Supply		2.8		-	-	-
Each Register (Max. 48)		0.2			1.3	
Each Sender (Max. 20)	-	-	-		1.0	
Each Tone Dial Detector		0.43		-	-	-
Each 1,000 Directory Numbers	-	-	-		5.6	
Each Toll MF Detector		0.5		-	-	-
+48v Message Registration		3.5		-	-	-
+48v Paystation Coin Control		1.5		-	-	-
Aux. Common Control Cabinet		6.8			16.6	
Aux. Line/Trunk Marker		4.2			14.0	
Each Line Unit (1350 CCS)		20.3		-	-	-
Each Line Unit (2000 CCS)		30.0		-	-	-
Loop Extender Power Supply (3 amps per 49 loops)		3.0		-	-	-
Customer Drain		As Req'd.			As Req'd.	
Total Drain	48-Volt			8-Volt		

EXAMPLE

Stromberg-Carlson ESC-3
500 Lines
1000 Directory Numbers

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control Cabinet	1	23.8	23.8	1	48.6	48.6
Translator	1	4.2	4.2	1	77.7	77.7
Test Cabinet	1	3.7	3.7	1	10.0	10.0
Power Supervisory	1	24.7	24.7	-	-	-
Register Common	-	-	-	1	12.0	12.0
Call Generator	1	0.6	.6	1	4.8	4.8
MF Current Supply	1	2.8	2.8	-	-	-
Each Register (Max. 48)	8	.0.2	1.6	8	1.3	10.4
Each Sender (Max. 20)	-	-	-	5	1.0	5.0
Each Tone Dial Detector		0.43		-	-	-
Each 1,000 Directory Numbers	-	-	-	1	5.6	5.6
Each Toll MF Detector		0.5		-	-	-
+48v Message Registration		3.5		-	-	-
+48v Paystation Coin Control		1.5		-	-	-
Aux. Common Control Cabinet		6.8			16.6	
Aux. Line/Trunk Marker		4.2			14.0	
Each Line Unit (1350 CCS)	1	20.3	20.3	-	-	-
Each Line Unit (2000 CCS)		30.0		-	-	-
Loop Extender Power Supply (3 amps per 49 loops)	1	3.0	3.0	-	-	-
Customer Drain		As Req'd.	10.0		As Req'd.	
Total Drain	48-Volt		94.7	8-Volt		174.1

EXHIBIT D

ITT A-1 Pentaconta

I. Speech Path Drain

CCS (Intraoffice)		x 0.007 =	
CCS (Outgoing)		x 0.007 =	
CCS (Incoming)		x 0.008 =	
		Total	= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHCx RHT		
Intraoffice Calls				x 0.0008	
Outgoing Calls					
Assistance					
CAMA					
TSPS					
EAS					
Other					
Total Outgoing				x 0.0014 =	
Incoming Calls					
DDD					
EAS					
Other					
Total Incoming				x 0.0008 =	
				Total	= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit D - Continued

III. Marker Drain

BHC (Intraoffice)		x 0.0085 =	
BHC (Outgoing)		x 0.0026 =	
BHC (Incoming)		x 0.0057 =	
		Total	

= Marker Drain

IV. Connector Drain

Total Marker Drain		x 0.2 =	

= Connector Drain

V. Customer Equipment Drain

As Required

Total Current Drain equals sum of I through V.

EXHIBIT E

ITT PC-32B

I. Speech Path Drain

CCS (Intraoffice)		x 0.022 =	
CCS (Outgoing)		x 0.017 =	
CCS (Incoming)		x 0.017 =	
		Total	

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHC x RHT		
Intraoffice Calls				x 0.00014 =	
Outgoing Calls					
Assistance					
CAMA					
TSPS					
EAS					
Other					
Total Outgoing				x 0.00021 =	
Incoming Calls					
DDD					
EAS					
Other					
Total Incoming				x 0.00056 =	

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit E continued

III. Marker Drain

BHC (Intraoffice)				
BHC (Outgoing)				
BHC (Incoming)				
Total BHC		x 0.0019 =		= Marker Drai

IV. Customer Equipment Drain

As Required

Total Current Drain Equals Sum of I through IV.

ITT A-1 Pentaconta & PC-32B

Example

The following information is used to demonstrate the method used to calculate the current drain of the ITT A-1 and PC-32B systems.

2000 Lines
1.6 CCS/Line Originating

Outgoing Trunk Traffic		
Assistance	200 CCS	67 BHC
CAMA	400 CCS	167 BHC
EAS	800 CCS	533 BHC
Incoming Trunk Traffic		
DDD	600 CCS	250 BHC
EAS	800 CCS	533 BHC
Intraoffice Traffic	1800 CCS	1500 BHC

Register Holding Times	
Assistance	5 Seconds
CAMA	17 Seconds
Outgoing EAS	14 Seconds
DDD	7 Seconds
Incoming EAS	7 Seconds
Intraoffice	14 Seconds

Customer Equipment Drain 40 Amps

EXAMPLE

ITT A-1 Pentaconta

I. Speech Path Drain

CCS (Intraoffice)	1800	x 0.007 =	12.6
CCS (Outgoing)	1400	x 0.007 =	9.8
CCS (Incoming)	1400	x 0.008 =	11.2
		Total	33.6

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHCx RHT		
Intraoffice Calls	1500	14	21,000	x 0.0008	16.8
Outgoing Calls					
Assistance	67	5	335		
CAMA	167	17	2839		
TSPS					
EAS	533	14	7462		
Other					
Total Outgoing	767		10,636	x 0.0014 =	14.9
Incoming Calls					
DDD	250	7	1750		
EAS	533	7	3731		
Other					
Total Incoming	783		5481	x 0.0008 =	4.4
				Total	36.1

= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

EXAMPLE - Continued

III. Marker Drain

BHC (Intraoffice)	1500	x 0.0085 =	12.8
BHC (Outgoing)	767	x 0.0026 =	2.0
BHC (Incoming)	783	x 0.0057 =	4.5
		Total	19.3

= Marker Drain

IV. Connector Drain

Total Marker Drain	19.3	x 0.2 =	3.9

= Connector Drain

V. Customer Equipment Drain

As Required 40 AMPS

Total Current Drain equals sum of I through V.

33.6 + 36.1 + 19.3 + 3.9 + 40.0 = 132.9 AMPS

From the above ampere drain it is seen that either two 150 amp chargers or three 75 amp chargers should be provided. For a three-hour reserve, a 660 ampere-hour battery is required. (From Exhibit P, a final cell voltage 1.85 yields a factor of 4.7 for a three-hour reserve. Therefore, 4.7 132.9 = 625 AH. The next larger size is 660 AH.)

EXAMPLE

ITT PC-32B

I. Speech Path Drain

CCS (Intraoffice)	1800	x 0.022 =	39.6
CCS (Outgoing)	1400	x 0.017 =	23.8
CCS (Incoming)	1400	x 0.017 =	23.8
		Total	87.2

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHC x RHT		
Intraoffice Calls	1500	14	21,000	x 0.00014 =	2.9
Outgoing Calls					
Assistance	67	5	335		
CAMA	167	17	2839		
TSPS					
EAS	533	14	7462		
Other					
Total Outgoing	767		10,636	x 0.00021 =	2.2
Incoming Calls					
DDD	250	7	1750		
EAS	533	7	3731		
Other					
Total Incoming	783		5481	x 0.00056 =	3.1
				Total	8.2

= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

EXAMPLE continued

III. Marker Drain

BHC (Intraoffice)	1500			
BHC (Outgoing)	767			
BHC (Incoming)	783			
Total BHC	3050	x 0.0019 =	5.8	= Marker Drain

IV. Customer Equipment Drain

As Required 40 AMPS

Total Current Drain Equals Sum of I through IV.

87.2 + 8.2 + 5.8 + 40.0 = 141.2 AMPS

EXHIBIT F

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =

_____ x _____ = _____

Delay Dial Trunks CCS = _____
Local Register-Sender CCS = _____
Non-Delay Dial Trunk Register-Sender CCS = _____

Total CCS = _____

0.037 x Total CCS = Peak BH Drain
0.037 x _____ = _____ (A)

Trunks (See Note)

Type	Number		Drain
1W Incoming DD	_____	x 0.30 =	_____
1W Incoming NDD	_____	x 1.25 =	_____
2W DD	_____	x 0.15 =	_____
2W NDD	_____	x 0.62 =	_____
CAMA or SATT	_____	x 0.14 =	_____
Coin Completion	_____	x 0.35 =	_____

Total Trunk Drain _____ (B)

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial
NDD = Non-Delay Dial

Common Equipment

Common Control and General Office Drain
Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A)
(1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A) 6.0

Detection Equipment (Type 70A - 4 amps/system) _____
Customer Equipment (Carrier, loop extenders, etc.) _____

Total Common Equipment Drain _____ (C)

Total CXP-5 Drain = 0.8 x [A + B + C]
= 0.8 x _____ = _____

Automatic Electric
CXP-5

Example

The following information is used to demonstrate the method used to calculate the current drain of the Automatic Electric CXP-5 system.

2000 Lines
1.6 CCS/Line Originating
Delay Dial Trunks CCS 1000
Local Register Sender CCS 1800
Non-Delay Dial Trunk Register-Sender CCS 400
10 1W Incoming DD Trunks
5 1W Incoming NDD Trunks
20 2W DD Trunks
5 2W NDD Trunks
15 CAMA Trunks
5 Coin Completion
Ringing Generator - 5 Frequency - 25 Watt
One 70A System
40 amps Customer Equipment

EXAMPLE

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =

2000 x 1.6 = 3200

Delay Dial Trunks CCS = 1000
Local Register-Sender CCS = 1800
Non-Delay Dial Trunk Register-Sender CCS = 400

Total CCS = 6400

0.037 x Total CCS = Peak BH Drain
0.037 x 6400 = 236.8 (A)

Trunks (See Note)

Type	Number		Drain
1W Incoming DD	10	x 0.30 =	3.0
1W Incoming NDD	5	x 1.25 =	6.3
2W DD	20	x 0.15 =	3.0
2W NDD	5	x 0.62 =	3.1
CAMA or SATT	15	x 0.14 =	2.1
Coin Completion	5	x 0.35 =	1.8

Total Trunk Drain 19.3 (B)

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial
NDD = Non-Delay Dial

Common Equipment

Common Control and General Office Drain	6.0
Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A) (1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A)	5.0
Detection Equipment (Type 70A - 4 amps/system)	4.0
Customer Equipment (Carrier, loop extenders, etc.)	40.0

Total Common Equipment Drain 55.0 (C)

Total CXP-5 Drain = 0.8 x [A + B + C]
= 0.8 x 311.1 = 248.9

Exhibit G

Automatic Electric No. 1 - EAX

Line Drain

Number of lines x 0.027 amps/line (A)

Trunk Drain

Number of trunks x 0.15 amps/trunks (B)

Busy Hour Drain = A + B = (C)
Peak Busy Hour Drain = 1.33 x C = (D)

Common Control Drain

Up to 15,000 lines - 250 amps (E)
More than 15,000 lines - 510 amps

Customer Equipment Drain

As Required (F)

Total Busy Hour Drain = C + E + F

Total Peak Busy Hour Drain (Power Board) = D + E + F

Example: The following information is used to demonstrate the method for calculating the busy hour current drain of the Automatic Electric No. 1 - EAX:

4000 Lines -- 800 Trunks -- 100 Amps, Customer Equipment Drain

Calculation:

4000 lines x 0.027 amps/line	=	108 amps
800 trunks x 0.15 amps/trunk	=	120 amps
Busy Hour Drain		228 amps

Peak Busy Hour Drain = 1.33 x 228 = 303.2 amps

Common Control Drain = 250 a
Customer Equipment Drain = 1

Total Busy Hour Drain = 228+
Total Peak Busy Hour Drain =

EXHIBIT H

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =
Number of Lines x CCS per line x 0.025 amperes

_____ x _____ x 0.025 = _____

Customer Equipment Drain = _____

Total Drain = _____

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =
   Number of Lines x CCS per line x 0.014 amperes
   _____ x _____ x 0.014 = _____

2. One-way trunk, excluding intertoll, Drain =
   Trunks CCS x 0.01 amperes
   _____ x 0.01 = _____

3. Two-way, and one-way intertoll, trunk Drain =
   Trunks CCS x 0.0174 amperes
   _____ x 0.0174 = _____

4. Toll Recording Trunk Drain =
   Trunks CCS x 0.05 amperes
   _____ x 0.05 = _____

5. TSD Equipment Drain =
   TSD CCS x 0.015 amperes
   _____ x 0.015 = _____

6. Customer Equipment Drain = _____

Total Drain = 1 + 2 + 3 + 4 + 5 + 6 = _____

Calculating drain for Group Selector, Translator and Number Group:

Group Selector and Translator
1.5 amps per frame

Number Group
1.0 amp per frame

EXHIBIT I

North NX-1E

The current drain for the electromechanical portion of the NX-1E is calculated in the same manner as the NX-1D. To calculate the drain of the electronic part of the NX-1E, the following figures should be used:

Uprights Fully Equipped	Average Drain Per Upright
Receiver-Sender Originating (RSO)	11 amps
RSO - Auxiliary	7
Receiver-Sender Incoming (RSI)	10
Key Call Receiver/MF Receiver (KCR/MFR) (Assume all MFR's)	4
KCR/MFR Auxiliary (Assume all MFR's)	4
KCR/MFR (Assume all KCR's)	6
KCR/MFR Auxiliary (Assume all KCR's)	7
Key Call/MF Receiver Link (MFL)	3
Trunk Register Link (TRL)	6
500-Line Group	Number of Lines x UC/L x 0.0075
3-Stage Group Selector	14
CPU Pair	17
Data Memory	15
Miscellaneous Data Transfer Unit	3
Tape Unit	5

North NX-1D and NX-1E

Example

The following data is used to demonstrate the method used to calculate the current drain of the North NX-1D and the electromechanical portion of the NX-1E. The necessary information to calculate the required drain of the NX-1E electronic circuits is shown in Exhibit I.

Class 5 Office	
2000 Lines	
2.0 CCS/Line Originating	
Customer Equipment Drain	40 Amps
Class 5 Office with Ticketing	
2000 Lines	
2.0 CCS/Line Originating	
100 Two-Way Intertoll Trunks	2800 CCS
100 Two-Way EAS Trunks	2800 CCS
75 One-Way Toll Completing Trunks	2000 CCS
75 One-Way Intertoll Trunks	2000 CCS
125 Toll Recording Trunks	3600 CCS
12 TSD Positions	1200 CCS
Customer Equipment Drain	40 Amps

EXAMPLE

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =
Number of Lines x CCS per line x 0.025 amperes

2000 x 2.0 x 0.025 = 100
Customer Equipment Drain = 40
Total Drain = 140

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =
   Number of Lines x CCS per line x 0.014 amperes
   2000 x 2.0 x 0.014 = 56.0

2. One-way trunk, excluding intertoll, Drain =
   Trunks CCS x 0.01 amperes
   2000 x 0.01 = 20.0

3. Two-way, and one-way intertoll, trunk Drain =
   Trunks CCS x 0.0174 amperes
   7600 x 0.0174 = 132.2

4. Toll Recording Trunk Drain =
   Trunks CCS x 0.05 amperes
   3600 x 0.05 = 180.0

5. TSD Equipment Drain =
   TSD CCS x 0.015 amperes
   1200 x 0.015 = 18.0

6. Customer Equipment Drain = 40.0

Total Drain = 1 + 2 + 3 + 4 + 5 + 6 = 446.2

EXHIBIT J

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

Constant		125 amps
$\frac{\text{Total Busy Hour Calls}}{1000} \times 1$ amp (Minimum 10 amperes)	=	
Incoming CCS x 0.01	=	
Outgoing CCS x 0.00925	=	
Originating Intraoffice CCS x 0.0145	=	
Total Negative 48-Volt Current Drain	=	

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.

2. For offices with Centrex features, add 25 amperes.

II. Positive 24-Volt Current Consumption

A.	Common Equipment (CPU's, CCTC, PMC, etc.)	42.0 amps
B.	Call Stores:	
	Ferrite Sheet Memory, Basic 16K Words	10.8 amps
	, First Supplementary 8K Words	8.0 amps
	, Second Supplementary 8K Words	2.8 amps
	MOS Memory, Basic 16K Words	5.1 amps
	, Supplementary 8K Words	1.3 amps
C.	Program and Data Stores:	
	Piggyback Twister Memory, Basic 16K Words	5.2 amps
	, Supplementary 16K Words	2.2 amps
	MOS Memory, Basic 32K Words	13.8 amps
	, Supplementary 16K Words	5.2 amps
D.	Centrex Data Line Units (16 Data Lines)	8.0 amps
E.	LAMA	3.0 amps
F.	Per 1000 Line Appearances	1.0 amps

Northern Electric SP-1

Example

The following data is used to demonstrate the method of calculating the negative 48-volt current drain of the Northern Electric SP-1 system.

Total Busy Hour Calls (Originating and Terminating)		12,000 BHC
Incoming CCS	3000 CCS	
Outgoing CCS	3000 CCS	
Originating Intraoffice CCS	4000 CCS	

The majority of subscriber loops are 1900 ohms or less.

EXAMPLE

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

Constant		125 amps
$\frac{\text{Total Busy Hour Calls x 1 amp}}{1000}$ (Minimum 10 amperes)	$\frac{12,000}{1000} \times 1$	= 12
Incoming CCS x 0.01	3000 x .01	= 30.0
Outgoing CCS x 0.00925	3000 x .00925	= 27.8
Originating Intraoffice CCS x 0.0145	4000 x .0145	= 58.0
Total Negative 48-Volt Current Drain		= 252.8
Add for short loops		+ 20.0
		272.8

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.

2. For offices with Centrex features, add 25 amperes.

EXHIBIT K

Nippon Electric Crossbar Systems (NC-10, NC-23, NC-400 and NC-460)

I. Negative 48-Volt Main Power Requirement

A. Average Current Drain

$$Iav = (A+B) \times C \times \frac{K}{36} \quad \text{where}$$

Iav = Average Current in Amperes
A = Originating CCS Per Line
B = Terminating CCS Per Line
C = Number of Lines
K = 0.41 for NC-10
K = 0.51 for NC-23
K = 0.53 for NC-400 and NC-460

B. Peak Current Drain

$$Ipk = Iav + 4.48 \sqrt{Iav} \quad \text{where}$$

Ipk = Peak Current in Amperes
Iav = Average Current in Amperes

II. Positive 50-Volt Power Requirement

A. 0.58 amps per Dial Tone Marker (NC-400)

B. 1.42 amps per Completing Marker (NC-400)

C. 1.42 amps per Marker (NC-23, NC-460)

Nippon Electric Crossbar Systems

Example

The following data is used to demonstrate the method of calculating the current drain for the NC-10, NC-23, NC-400 and NC-460 systems.

Originating CCS Per Line	1.6 CCS/Line
Terminating CCS Per Line	1.6 CCS/Line
Number of Lines	2000 Lines
Dial Tone Markers (NC-400)	3
Completing Markers (NC-400)	3
Markers (NC-23, NC-460)	3

Negative 48-volt Main Power Requirement:

NC-10

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.41}{36} = 73 \text{ amps}$$

$$Ipk = 73 + 4.48\sqrt{73} = 111.3 \text{ amps}$$

NC-23

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.51}{36} = 90.7 \text{ amps}$$

$$Ipk = 90.7 + 4.48\sqrt{90.7} = 133.3 \text{ amps}$$

NC-400 and NC-460

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.53}{36} = 94.2 \text{ amps}$$

$$Ipk = 94.2 + 4.48\sqrt{94.2} = 137.7 \text{ amps}$$

Positive 50-volt Power Requirement:

NC-23 and NC-460

$3 \times 1.42 = 4.26$ amps

NC-400

$3 \times 0.58 + 3 \times 1.42 = 6$ amps

EXHIBIT L

Power Requirements for Stromberg-Carlson Toll Ticketing Equipment

The following busy hour current drains should be used when calculating power requirements for Stromberg-Carlson automatic toll ticketing equipment:

1.0 ampere per recorder
2.0 amperes per identifier (usually 1 identifier)
4.0 amperes per data register (1 register/3.5 trunks)
2.0 amperes per sender (1 sender/4 recorders)
4.0 amperes miscellaneous

Example:

An automatic toll ticketing system contains the following equipment: 17 recorders, 1 identifier, 4 data registers and 4 senders.

The following drains are totaled:

Recorders	17 x 1.0	=	17
Identifier	1 x 2.0	=	2
Data Registers	4 x 4.0	=	16
Senders	4 x 2.0	=	8
Miscellaneous			4
Total Drain			47 amperes

EXHIBIT M

ITT Tel Touch

The following formulae should be used to calculate the additional busy hour current drain when ITT Tel Touch (pushbutton dialing) equipment is installed:

1. Total Originating Call Drain

$$\frac{\text{Total Originating Traffic (UC)} \times 0.046}{36} = \_\_\_\_\_ \text{ amps}$$

2. Traffic to Register Drain*

$$\frac{\text{BHC} \times \text{Register Holding Time}}{3600} \times (\text{Register Current} + 0.04) = \_\_\_\_\_ \text{ amps}$$

$$\text{BHC} = \frac{\text{Unit Calls} \times 100}{\text{Call Holding Time}}$$

Register Holding Time (RHT) =
2.5 + (1.5 seconds/digit x number of digits)

*Repeat this calculation for each type of traffic to registers, i.e., local, toll, CAMA, EAS, etc.

Register Current Table

Number of Digits Handled	Current
1	1.2
2	1.2
3	1.5
4	1.5
5	1.65
6	1.65
7	2.0
8	2.0
9	2.3
10	2.3
11	2.55
12	2.55
13	2.8

Exhibit M Continued-2

3. Allotter Drain

Total BHC x 0.00047 = _____ amps

4. Peak Drain

Total Drain (1 + 2 + 3) x 1.03 = _____ amps

Example:

A 300-line office equipped with 100% Tel Touch has the following traffic parameters:

Total Originating Traffic = 300 lines x 1.4 UC/L = 420 UC
9 Toll Trunks = 126 UC ÷ 2 = 63 UC
7 EAS Trunks = 84 UC ÷ 2 = 42 UC

Equal traffic is assumed in both directions on 2-way trunks.

Total Local Originating Traffic = 420 - (63 + 42) = 315 UC

Assume 120 second holding time.

$$\text{Local Originating BHC} = \frac{315 \times 100}{120} = 263 \text{ BHC}$$

Toll holding time is assumed to be 270 seconds.

$$\text{Toll Originating BHC} = \frac{63 \times 100}{270} = 23 \text{ BHC}$$

EAS holding time is assumedto be 150 seconds.

$$\text{EAS Originating BHC} = \frac{42 \times 100}{150} = 28 \text{ BHC}$$

Local Traffic - 7 Digits
Toll Traffic - 1 Digit
EAS Traffic - 7 Digits

Register Holding Time (RHT) - Local

Register Holding Time (RHT) - Toll

Exhibit M Continued-3

The following shows the calculation of the busy hour current drain:

1. Total Originating Call Drain = $\frac{420 \times .046}{36}$ = .54 amps

2. Local Traffic to Register Drain = $\frac{263 \times 13}{3600} \times (2+.04)$ = 1.94 amps

   EAS Traffic to Register Drain = $\frac{28 \times 13}{3600} \times (2+.04)$ = .21 amps

   Toll Traffic to Register Drain = $\frac{23 \times 4}{3600} \times (1.2+.04)$ = .03 amps

3. Allotter Drain = (263 + 28 + 23) x .00047 = .15 amps

   Total Drain = 2.87

4. Peak Drain = 2.87 x 1.03 = 3.0 amps

EXHIBIT N

Stromberg-Carlson Tone Dialing

To calculate the current drain of Stromberg-Carlson tone dialing equipment, use one ampere for each converter.

To calculate the number of converters required, use the following formula:

$$\frac{\text{Number of Lines} \times \text{UC/L}}{\text{Avg. Call Holding Time}} \times \text{Average Converter Holding Time} = \text{UC to Converters}$$

Using the P.01 Table, find the number of converters required.

Example:

Given:

400 Lines
1.5 UC/L
Call Holding Time - 180 seconds
Converter Holding Time - 10 seconds

Find current drain of Tone Dialing equipment.

Using the above formula, the traffic to the converters is

$$\frac{400 \times 1.5}{180} \times 10 = 33.3 \text{ UC}$$

From the P.01 Table, 5 converters are required. Therefore, the current drain is

5 x 1 amp/converter = 5 amps

EXHIBIT O

Transmission Electronics Current Drain

Equipment	48-Volt Battery Drain Amperes Per Unit
Loop Extenders	0.075
VF Repeaters	
1. Negative Impedance	0.035
2. Hybrid	0.035
3. Automatic Gain Control	0.080
4. Loop Extender - Repeater Combination	0.100
5. Automatic Gain Control Loop Extender - Repeater Combination	0.200
Carrier Systems	
1. D1/T1, D2/T1, or D3/T1*	3.0
2. TCS-28	3.0
3. N3	3.0 for 1 system and 5.1 for 2
4. N1 or N2	1.8
5. 24-Channel PCM Subscriber Systems - CO End	3.0
6. D960	6.0
7. Station Carrier Channel**	0.13

*Note 1: Central office terminal current is approximately 2.0 amperes and span power supply current is 1.0 ampere. Add an additional ampere if a spare span line is used.

**Note 2: The power requirements for multichannel types of station carrier depend on the manufacturer, type of equipment (including specific options), and the system length. Refer to the carrier manufacturer's literature for specific central office battery current requirements (about 0.06 to 0.25 amperes per carrier channel). For estimating purposes, allow 0.13 amperes per carrier channel. The power requirements for the one channel station carrier is about 0.035 amperes per carrier channel.

EXHIBIT P

Estimating Telephone Battery Sizes to Meet Various Reserve Requirements

Number of Busy Hours Reserve	8-Hour Ampere Hour Capacity Required for Each Ampere of Busy Hour Load				
	Final Cell Voltages				
	1.75	1.80	1.85	1.90	1.95
1	2.2	2.5	2.8	3.5	5.0
2	3.2	3.4	3.7	4.7	6.2
3	4.0	4.3	4.7	5.6	7.5
4	4.9	5.1	5.6	6.5	8.6
5	5.7	6.0	6.5	7.4	9.6
6	6.5	6.8	7.3	8.2	10.6
7	7.2	7.6	8.1	9.1	11.6
8	8.0	8.3	8.9	10.0	12.6
9	8.8	9.1	9.6	10.9	13.7
10	9.5	9.9	10.4	12.0	15.0

Examples:

1. Required: The capacity of a 24-cell battery to handle a 3-hour load of 34.0 amperes to a limiting voltage of 44 volts.

   $\frac{44}{24} = 1.83$ Use 1.85 Volts

   From the above chart each ampere of busy hour load requires 4.7 ampere hours of capacity.

   Total capacity required = 4.7 x 34.0 = 160 ampere hours.
   Select the next larger catalog size.

2. Calculate the ampere hour reserve of an existing 24-cell, 480-ampere hour battery with the busy hour load increased to 84 amperes to a final voltage of 1.75 volts.

   Formula: $K = \frac{B}{C}$

   where

   K = 8-hour ampere hour capacity requir
   of busy hour load.
   B = Ampere hour capacity of existing b
   C = Actual busy hour current drain of

   $K = \frac{480}{84} = 5.7$

   On the chart, locate 5.7 in the 1.75-volt co
   left read 5 hours' reserve.